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TYPE 2120-A

SIGNAL GENERATOR

R.F. PICTURE

INSTRUCTION BOOK

TIC

Tel-Instrument Co. Inc.

728 GARDEN STREET
CARLSTADT, NEW JERSEY

TYPE 1212
R. F. WOBBULATOR

SECTION 1
GENERAL DESCRIPTION

1. INTRODUCTION

The purpose of this handbook is to supply information concerning the use, theory of operation and maintenance of the Type 1212 R. F. Wobbulator. Since this is a rather complex instrument consisting of nineteen vacuum tubes and their associated circuits, it is strongly recommended that this handbook be carefully read before attempting to use the instruments and especially before attempting to make any adjustments or repairs.

2. PURPOSE AND BASIC PRINCIPLES

a. GENERAL - The Type 1212 is a R. F. Signal Generator covering each of the standard television channels from 2 to 13 inclusive, providing a swept or "wobbulated" frequency of constant amplitude 15 MC wide centered on each band as shown in Table 1-1.

TABLE 1-1
FREQUENCY BAND AND MARKER FREQUENCIES

Channel	Freq. Band	Marker Freq. Visual	Marker Freq. Sound
IF	- -	-	-
2	50 - 65	55.25	59.75
3	56 - 71	61.25	65.75
4	62 - 77	67.25	71.75
5	72 - 87	77.25	81.75
6	78 - 93	83.25	87.75
7	170 - 185	175.25	179.75
8	176 - 191	181.25	185.75
9	182 - 197	187.25	191.75
10	188 - 203	193.25	197.75
11	194 - 209	199.25	203.75
12	200 - 215	205.25	209.75
13	206 - 221	211.25	215.75

In addition, a spare channel is provided which can be set at special frequencies as required.

Each of the channels may be instantly selected by means of a thirteen-position rotary switch.

The output is at the fundamental frequency of the oscillator on each band and has an amplitude of at least 0.5 volts peak across 75 ohms on all channels. The output signal may be varied in amplitude by means of step and variable type attenuators over a range of approximately 80 Db with a maximum output of at least 0.5 volts peak across 75 ohms on all channels. Each channel has markers at the picture and sound carrier points. These markers are crystal generated and individually accurate, and may be used for the precise adjustment of the local oscillator in the television receiver "R. F. head". There are no self excited oscillators used in the marker generating system that can drift and cause erroreous adjustments. A zero signal reference base line is provided to permit proper evaluation of signal amplitudes.

b. PURPOSE - The primary purpose of the Type 1212 is to provide a suitable signal for the adjustment of R. F. heads for television receivers. An "R. F. head" consists generally of an R. F. amplifier stage, a mixer or converter, and an oscillator. The R. F. amplifier input and output networks may be adjusted independently of the local oscillator; in fact the local oscillator may be inoperative. This is usually done by applying the signal from the Type 1212 to the antenna input terminals and connecting the input terminals of a fairly high gain oscilloscope having good low and high frequency response such as the DuMont Type 304-A, to the grid circuit of the mixer tube. Usually the grid resistor of the mixer consists of two resistors in series so that the resistor nearest ground potential may be used, the upper resistor providing the necessary R. F. isolation from the effects of the scope leads. The rectified grid current of the mixer tube will then be observed as a trace on the scope and the frequency amplitude characteristics of the amplifier input and output circuits may be observed and adjusted. Since the output signal of the Type 1212 covers a 15 MC band, the entire response of these circuits may be observed.

Fig. 1-1 shows a typical response curve with the internal markers of the Type 1212 "ON". By connecting a lead, from either the Plus or Minus External Pulse terminals on the front panel, to the scope through a series resistor, the markers can be made to extend above the curve or below the baseline. With an internal switch the internal markers can be turned "OFF" and by using either of the two External Pulse Terminals the markers will extend either up or down from the response curve as shown in Figures 1-2 and 1-3. The amplitude of the pulses can generally be varied from zero to at least five times as great as that of the response curve itself when aligning the R. F. Tuner or I. F. Amplifier of a television receiver. This should considerably facilitate the alignment of sound traps.

(1) R. F. Head Oscillator Adjustment: The local oscillator setting adjustment may be made precisely by the simple arrangement of Fig. 1-4.

The signal from the Type 1212 is fed to the antenna input terminals of the R. F. head under test. The output of the R. F. head is fed to a wide band I. F. amplifier having constant amplitude response over at least 6 to 8 MC and over the frequency band intended for use with the output of the R. F. head. The output of the I. F. amplifier should consist of a suitable detector and the signal from this detector should be applied to the Y axis input of a scope. In order to permit properly adjusting the local oscillator, we must now add a small signal by capacitive coupling to the input of the I. F. amplifier. This signal should be obtained from a crystal controlled oscillator whose frequency corresponds to that of either the I. F. sound or picture carrier frequency. Usually the I. F. sound carrier frequency

SECTION 1

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1. INTRODUCTION

The purpose of this handbook is to supply information concerning the use, theory of operation, and maintenance of the Type 2120-A R.F. Picture Signal Generator. Since this is a fairly complex instrument consisting of 30 tubes and their associated circuits, it is strongly recommended that the user of this instrument read this handbook carefully before attempting to use it, and especially before attempting to make any adjustments or repairs.

2. PURPOSE AND BASIC PRINCIPLES

a. GENERAL. - The Type 2120-A is actually a miniature television broadcasting station intended for use in television receiver testing in the factory or laboratory. It develops both a picture and sound carrier on any one of the 12 standard television channels. The picture carrier is of the double sideband type as specified in current I.R.E. and R.M.A. test standards, the sound carrier is capable of FM with at least 40 KC deviation. The picture carrier must be modulated from an external signal source usually from a "Monoscope Camera." It may also be modulated by square wave or pulse type signals f[redacted] special tests. The sound carrier may be modulated by the internal 400 cycle generator or from an external source such as music. A standard 75 microsecond pre-emphasis network is provided in accordance with R.M.A. standards.

The output on picture carrier is at least 0.5 V. peak across a 75 ohm line when modulated 87% with a standard composite television picture signal. The sound carrier is adjustable from 25% to more than 100% of the picture carrier. The output signal may be varied over a range of 80 Db by means of a 40 Db and 20 Db toggle switch step attenuator and a variable attenuator having a range of 20 Db. The attenuators are not of the precision type but will maintain their calibration once it has been determined and set up.

The sound carrier is "locked" to the picture carrier by an automatic frequency control system that maintains the sound carrier plus 4.5 MC ±4 KC with respect to the picture carrier. Adequate isolation is provided between the crystal oscillators and the modulated output stage to limit the phase modulation of the picture carrier by the video signal, to a level of minus 50 DB with respect to the signal created by FM deviation of 25 KC on the sound carrier with both carriers adjusted to equal peak amplitudes and the picture carrier modulated to 90%. This unusually high degree of immunity to incidental phase modulation makes the Type 2120-A particularly suitable for testing of "intercarrier sound" type of receivers. Tests made on the finest

television broadcast stations on the air today show that their performance is no better and often much worse than the Type 2120-A for incidental phase modulation.

The video modulator of the Type 2120-A contains a video gain control to adjust the level of the video input signal to the proper level. The video modulation percentage may be observed at the "MON" terminals on the front panel by means of a high frequency scope. Any scope having adequate gain, and a frequency response flat to 2 MC or greater, will be satisfactory for this purpose. An internal "chopper" shorts the output of the crystal rectifier to the "MON" terminal at a 60 c.p.s. rate thus creating a zero signal reference level.

Details of setting up the Type 2120-A for use and operation are contained in subsequent paragraphs.

b. PURPOSE. - The primary purpose of the Type 2120-A is to provide a suitable television picture and sound signal to properly test and adjust television receivers. Even though in some manufacturing areas, local television station signals may be available with test patterns, these signals are not reliable for steady production testing. Some of the major drawbacks to using broadcast signals for testing are as follows:

(1) Horizontal and vertical linearity is seldom within acceptable limits.

(2) The test patterns usually show resolution up to 250 lines, seldom more. They are intentionally designed to make almost any receiver look good. Such signals are inadequate for testing of high quality, or even to determine the "relative" quality of medium quality receivers.

(3) Reflected signals from neighboring objects, airplanes, etc., introduce spurious signals and create peculiar effects that make it difficult to quickly determine whether the signal or the receiver under test is at fault. This results in wasted test time.

The use of the Type 2120-A in conjunction with a "Monoscope Camera" signal having at least 400 lines resolution together with a bar and dot linearity signal generator such as the Tel-Instrument Type 2000 will permit complete, quick and accurate adjustment of deflection circuits for linearity and also provide a complete check of the following receiver characteristics.

(4) Transient response (ringing)

(5) Resolution capability

(6) "Sync" separator operation

(7) AGC operation

(8) Freedom from improper operation of the "Intercarrier Sound" circuits as evidenced by lack of a 60 cycle buzz. This point is more fully covered in succeeding paragraphs.

Since the Type 2120-A is equivalent to a high quality television broadcast station, receiver operating data under all sorts of signal conditions may be taken. Conditions may be set up that are more stringent than those encountered in the field, thus giving the Quality Control man the confidence that the receivers will be satisfactory to the customer.

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The Tel-Instrument Co., Inc., warrants each new product manufactured by it to be free from defective material and workmanship and agrees to remedy any such defect or to furnish a new part in exchange for any part of any unit of its manufacture which under normal installation, use and service discloses such defect, provided the unit is delivered by the owner to us intact, for our examination, with all transportation charges prepaid to our factory, within ninety days from the date of sale to original purchaser and provided that such examination discloses in our judgment that it is thus defective.

This warranty does not extend to any of our products which have been subjected to misuse, neglect, accident, incorrect wiring not our own, improper installation, or to use in violation of instructions furnished by us, nor extend to units which have been repaired or altered outside of our factory, nor to cases where the serial number thereof has been removed, defaced or changed, nor to accessories used therewith not of our own manufacture.

Parts will be made available for a minimum period of five (5) years after the manufacture of this equipment has been discontinued.

Parts include all materials, charts, instructions, diagrams, accessories, et cetera, which have been furnished in the standard model.

This warranty is in lieu of all other warranties expressed or implied and no representative or person is authorized to assume for us any other liability in connection with the sale of our radio products.

ADDITIONAL INFORMATION with regard to the applications and maintenance of this equipment will be available from time to time. Users of our instruments are urged to discuss their problems with us and to suggest such modifications as might make them more adaptable to their special requirements.

MAINTENANCE difficulties should be reported before proceeding with actual repairs, since our familiarity with such problems will usually suggest a simpler procedure.

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SECTION 2

OPERATING INSTRUCTIONS

1. OPERATING INSTRUCTIONS

a. GENERAL. - The Type 2120-A consists of 3 chassis; Power Supply, Video Amplifier, Frequency Control Audio Oscillator chassis, hereafter termed the "VAFCAO" unit, and the R.F. Chassis. The R.F. chassis for channel 2 - 6 differs from that of channels 7 - 13 only to the extent that one stage of frequency multiplication has been omitted for chassis used on channels 2 - 6. Of course the video carrier crystal frequency and the operating frequencies of the various coils used in the tuned circuits of the frequency multipliers and output stages vary from channel to channel. The R.F. chassis for both the lower and higher channels is identical and by the addition or removal of 2 tubes and a few components, plus the necessary changes to crystals and coils, any channel can be readily converted to any other channel.

b. PLACING TYPE 2120-A INTO SERVICE. - After unpacking the unit and BEFORE connecting the power cord to 117 VAC line, lift the cover of the cabinet and make certain that both crystals X1 and X2 are in their sockets and that all tubes are in their respective sockets. If any crystals or tubes are missing from any sockets, look for the missing part inside of the cabinet. If found to be undamaged, replace it. Connect the output cable and probe, marked H and G adjacent the terminals, to the output receptacle on the front panel. Take care that the inner conductor fits properly into the center connector of the receptacle. Before assembling the probe to the cable, check it with an ohmmeter. One probe will read open circuit, this is for use with 75 ohm receiver inputs, the other will measure 350 ohms and is for use with 300 ohm balanced input receivers. Take the 75 ohm probe and solder a 75 ohm or 68 ohm resistor across the terminals. This will serve to terminate the 4 ft. coaxial cable. Assemble the probe to the cable. If R.F. output measurements are desired then connect the probe of a Hewlitt Packard Type 410A VTVM across the resistor. Then plug in the power plug to the 117 VAC line and operate the front panel power switch to the "ON" position and note whether the pilot light glows. If it does not glow, note whether the heaters of the 6B4G and 5R4GY on the power supply chassis are glowing. If not, then replace the fuse or check to see whether power line is "live." Assuming that the unit is in proper working order, let it warm up for about 5 minutes, meanwhile connect up the video line to the connector at the rear and connectthe probe of a DuMont Type 303 or Tecktronics 524-514 scope or equal to the "MON" posts on the front panel. Any oscilloscope having good gain and a frequency response flat to at least 2 MC is satisfactory. CAUTION: do NOT use a DuMont 304 or similar low frequency scope as the video signal will be almost completely filtered out and serious discrepancies in setup of modulation percentage will result.

Operate the toggle switch labeled "Relay" on the front panel to the "ON" position and listen carefully, placing the ear near the top of the cabinet and verify that the chopper is operating by means of the audible buzz. Now adjust the scope gain to give a convenient deflection of about 2 inches and lock the scope sweep to 60 cycle line.

c. VIDEO MODULATION ADJUSTMENTS. - Note whether a suitably large pattern appears on the scope. Assuming it does, proceed with the video modulation adjustments.

The FIRST step is to reach inside the cabinet and operate the toggle switch marked "AUDIO" to the "OFF" position. If this is not done the sound carrier output will mess up the video carrier presentation on the scope and prevent a proper setup. Be sure that the sound carrier is off by operating the audio switch a few times and noting the effect on the pattern. After turning the AUDIO switch "OFF" you may proceed with the video modulation setup.

Check to ascertain that the video signal line is connected to the coaxial connector J-1 at the rear of the unit and make absolutely sure that a 75 ohm resistor is used to terminate the line at J-1. WARNING: do NOT attempt to set up the video madulation or even expect to get any kind of picture signal unless the video line is PROPERLY terminated in its CHARACTERISTIC IMPEDANCE at J-1. The 75 ohm value only holds for 75 ohm coaxial cables. If 92 ohm or 50 ohm cables are used, then a 92 ohm or 50 ohm termination MUST be used. If several Type 2120-As are connected to a single video line, then the termination must be placed at the last unit on the cable away from the signal source. Check the signal being fed into J-1 and be sure it has at least a 1.0 V P-P amplitude and that the signal polarity is "BLACK NEGATIVE" as defined in current RMA standards proposals and in F.C.C. "Standards of Engineering Practices" for television broadcast stations. If the signal is NOT "black negative" then it CANNOT BE USED. In this event a polarity reversing amplifier must be inserted in series with the cable. This problem should not arise if the signal is being obtained from any system that conforms to RMA standards.

Having verified the amplitude and polarity of the video input signal, now adjust the "VIDEO GAIN" control on the VAFCAO chassis first to a maximum "COUNTERCLOCKWISE", and then slowly in a CLOCKWISE direction, meanwhile observing the pattern on the scope. In the maximum counterclockwise position of the "VIDEO GAIN" control the pattern will appear as shown on Fig. 2-2; this pattern indicates NO video modulation. As the "VIDEO GAIN" control is rotated in the clockwise direction, the pattern will increase in amplitude and appear eventually as shown on Figs. 2-3 and 2-4. Fig. 2-4 shows a signal adjusted to 90% modulation and standard 25% "sync."

WARNING: If the video modulation is increased beyond 90% then an audible 60 cps buzz will be heard in INTERCARRIER SOUND receivers but not in receivers having a separate sound I.F. system. This situation exists because with intercarrier sound type receivers the sound signal is created by the 4.5 MC modulation product of the picture and sound carrier at the second detector. If the picture carrier is reduced to zero, which is what happens with 100% modulation, then the picture carrier signal disappears and there can be no modulation product between the picture and sound carriers, hence no "intercarrier sound" signal. Since the picture modulation of television signals has a field repetition rate of 60 fields per second, the picture carrier will be cut off 60 times per second thus creating a 60 cycle buzz in the loud speaker. As a general rule it is best to maintain the video or picture modulation at the 87 ±2.5% level in accordance with current RMA standards proposals. If the 60 cycle buzz still persists at the 87% modulation level, then the receiver is defective or requires redesign.

An important point to bear in mind when adjusting the modulation level using a scope connected at the "MON" terminals is that the crystal rectifier and resistor R-10 shown on drawing 2120-50-5 cuts off considerable of the high frequency portion of the video spectrum. Frequency components above 3 MC are attenuated. Also, unless an exceptionally high frequency response scope is used to view the signal, the components above 2 MC will be severely attenuated. For this reason it is not advisable to use the "MON" output signal to set the amplitude relationship between the video and blanking level. The signal makeup of a composite picture signal MUST be checked at the input to J-1 by means of a scope having a frequency response flat to at least 5 MC and preferably 10 MC.

d. SOUND CARRIER ADJUSTMENT. - Using the same setup as described in Par. 2-c, note the height of the pattern using the chopper relay and with video modulation properly adjusted on the scope and with the sound carrier turned "OFF" (AUDIO switch OFF). Now operate the adjacent "VIDEO" carrier toggle switch to the "OFF" position and note the disappearance of the signal, then turn the "AUDIO" switch "ON" and note the amplitude of the pattern. Adjust R50 on the rear edge of the RF chassis either clockwise or counterclockwise until the amplitude of the pattern is 50% of the amplitude of the picture carrier. This will give a sound to picture carrier ratio of 50% and is the minimum ratio that should be used. The sound carrier may be increased to 100% of the picture carrier if desired. Turn the chopper relay "OFF".

The next step is to set up the FM deviation to produce a ±25 KC swing. This may best be done by the method outlined by Hund in "Frequency Modulation" Chapter 1 Sec. 16, Page 85. It may also be

done in a rough way be tuning in a local television station while the test pattern and tone modulation is being transmitted, and note the reading across the speaker voice coil, then substitute the output of the Type 2120-A and adjust the "Audio Gain" control of the Type 2120-A to give the same reading. Be sure the front panel "400 cycle MOD" switch is in the "ON" position. This method is only valid when the broadcast station signal is sufficiently strong to give a good, noise-free picture. It also assumes that the broadcast station is using ±25 KC deviation. This assumption is not always true as some stations do not necessarily comply with all FCC regulations and standards. For all practical purposes the method is adequate.

Another method is to use a standard television receiver having two I.F.s, that is a separate video and sound I.F., and use a Boonton Mod 202B F.M. Signal Generator set for 25 KC deviation instead of the broadcast station. This method is probably the easiest and sufficiently accurate for all practical purposes.

If external modulation, such as music, is desired instead of the 400 cps internal modulation, apply the external signal to the binding posts at the rear of the chassis using an external potentiometer or gain control to adjust the signal from 0 to 2 volts MAX RMS. Then operate the front panel "400 cycle MOD" switch to the "OFF" position and adjust the external signal level to give the same output at the receiver voice coil as for the 400 cps internal modulation.

e. FINAL ADJUSTMENTS. - Operate both the "VIDEO" and "AUDIO" toggle switches to the "ON" position and the unit is ready for use. If receivers having 300 ohm balanced inputs are to be tested, replace the probe at the end of the cable with the 300 ohm probe marked "H" and "L" adjacent to the solder terminals. Since the output of the Type 2120-A is at least 500,000 microvolts, it is necessary to reduce this signal by means of the front panel attenuator switches to a reasonable level. Usually the 100:1 attenuator should be "IN." The signal level best suited for a given receiver depends entirely on the design of the receiver and the type of test being made VIZ; low level sensitivity, or high level overload.

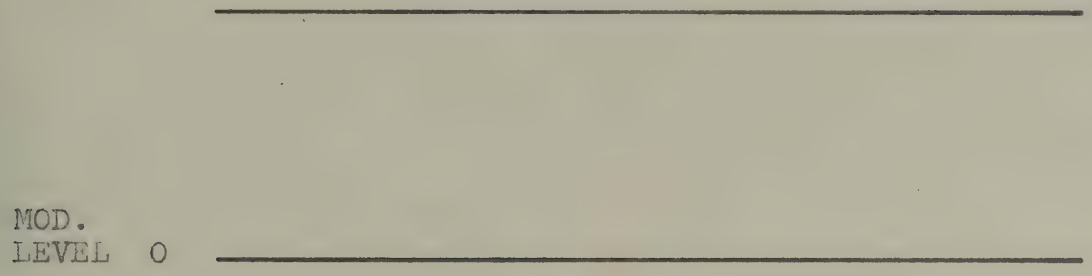


Fig. 2-2

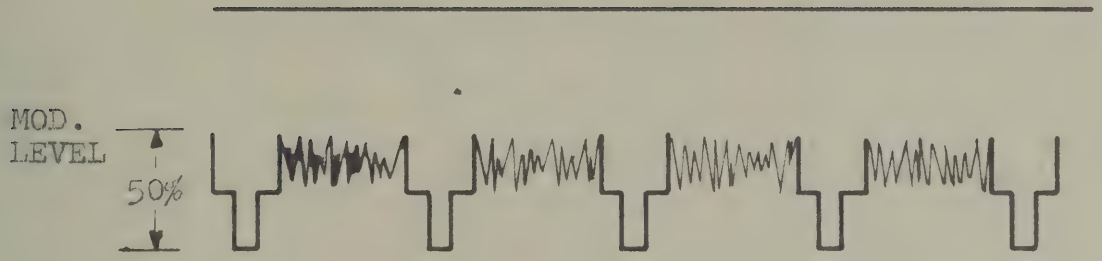


Fig. 2-3

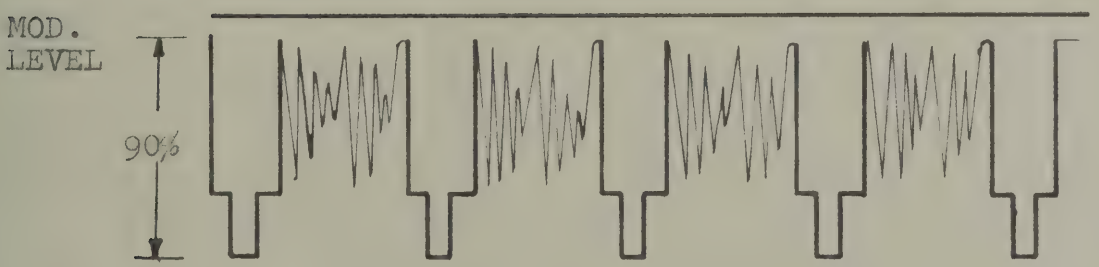


Fig. 2-4

SECTION 3

THEORY OF OPERATION

1. DESCRIPTION OF CIRCUITS

a. OUTLINE OF SYSTEM. - The Type 2120-A consists of two separate R.F. generators, one for the picture carrier, the other for the sound carrier; an automatic frequency control system that locks the sound carrier 4.5 MC above the picture carrier; a video amplifier and modulator system; an R-C type 400 cps audio oscillator and reactance tube to provide the FM; together with a regulated power supply. All of the circuits operate in a conventional manner therefore only a few points that might be helpful will be discussed in detail.

b. R.F. CHASSIS. - Refer to Figs. 4-2 and 4-3; both are schematics of the R.F. chassis. Fig. 4-2 covers channels 2-6 and Fig. 4-3 covers channels 7-13. Comparison of the two will reveal that the only difference is that 2 frequency multiplying stages V3 and V8, Fig. 4-3, for the picture and sound carrier generators have been omitted from Fig. 4-2. Since both low and high channel units are identical, the discussion will omit the V3 and V8 tube circuits for convenience. The picture carrier generator starts at V1 which is a crystal-controlled "Cathode Coupled" oscillator. It is termed a "Cathode Coupled" oscillator since the feedback necessary to create oscillation is obtained by a coupling network or crystal connected between the two cathodes of V1. The method of operation is as follows: Grid pin 7 of V1 is grounded, therefore a positive polarity signal applied to cathode pin 8 will have the same effect as a negative polarity signal on grid pin 7 and creates a large positive polarity signal across L1 on plate pin 6 which is fed thru C3 to grid pin 2 and causes the plate current thru plate pin 1 to cathode pin 3 to increase because the plate coil of pin 1 has no appreciable impedance at the crystal frequency. The increase in current creates a positive polarity signal across R3 which is transmitted thru the crystal X1 back to cathode pin 8, thus we have a regenerative network which will oscillate provided the gain of the 2 sections of the triode is sufficient to overcome the losses created by X1 and the cathode resistors R2, R3. This circuit can only oscillate if X1 is a very low impedance in the neighborhood of 50 ohms and can be made to oscillate either with a crystal connected between the 2 cathodes or by substituting a resistor for X1, having a value of approximately 50 ohms or less. If a resistor is substituted for the crystal, the circuit will oscillate at the resonant frequency of coil L1.

The operating frequency of the various stages is:

Channel 2-6			Channel 7-13			
V1	V2	V4.5	V1	V2	V3	V4.5
f	3f	3f	f	3f	9f	9f

where f is the frequency of the video carrier crystal as listed on Figs. 4-2 and 4-3. Frequency multiplication is accomplished in the usual manner. The output stage V4, V5 is a straight thru amplifier neutralized to balance out the internal grid to plate feed thru and permitting modulation over 90% up to channel 13. Video modulation is applied to the cathodes of V4, 5 across the cathode resistor R21. The R.F. output level and modulation characteristics are controlled by the voltage appearing across R21 which can be varied by means of the "MOD BIAS" control R15, Fig. 4-1. Some of the features of this adjustment will be covered later under the VAFCAO chassis discussion.

The sound carrier generator starts out with the cathode coupled oscillator V6, operating as a self-excited oscillator, which is reactance modulated by V11 in a conventional manner. The output is fed to V7 and succeeding multiplier stages to the output amplifiers V9, 10. The output level of V9, 10 is controlled by varying the screen potential thru R50. The oscillator V6 serves as a frequency doubler as well as a self-excited oscillator. The operating frequencies of the various multiplier stages are as follows:

Channel 2-6			Channel 7-13			
V1	V2	V4.5	V1	V2	V3	V4.5
f, 2f	6f	6f	f, 2f	6f	18f	18f

where f is the sound oscillator frequency as listed on Figs. 4-2, 4-3.

The control of the sound carrier frequency is accomplished by feeding some of the sound oscillator output to V12 which serves as an isolation amplifier. The output of V12 is fed to the #3 grid of mixer tube V13. A 1N34 crystal is connected across this grid to develop a constant bias voltage to grid #3 of V13. Part of V13 serves as an untuned crystal oscillator which operates at a frequency exactly 455 KC lower than the sound oscillator V1 when set precisely for a given channel. It is apparent therefore that if the sound oscillator mean frequency were to deviate to a value either above or below its proper frequency, then the difference frequency or beat output of V13 will also vary by the SAME NUMBER OF CYCLES. This output signal of V13 is then fed to V5, Fig. 4-1, which then feeds its output to the frequency discriminator network T3 and V6. V6 generates a DC control voltage which is applied to the No 3 grid of V11, Fig. 4-2, in such a polarity sense as to correct any deviation of sound carrier oscillator V6 in a conventional manner.

By using a separate reference crystal oscillator X2, V13 we eliminate modulation of the picture carrier by the sound carrier since there is no direct connection between the sound and picture channels except at the output circuits of the final amplifiers where

no modulation can take place.

The outputs of both generators are link coupled and the output links are tied together across the output cable. No special coupling networks have been found to be of any advantage or necessary.

It will be noted by examination of Fig. 4-2 that all grids have test points marked "TP" to permit determination of circuit operation by measuring the voltage at each test point with a voltohmyst.

c. VAFCAO CHASSIS. - This chassis schematic Fig. 4-1 contains the video amplifier and modulator, AFC discriminator circuits, R-C 400 cps oscillator, and an audio amplifier. None of these circuits have any novel features except perhaps the video modulator V4. In order to DC couple the modulator output to the R.F. output amplifier it was found necessary to generate the modulating signal across the cathode resistor R18 of V4. This provides a low impedance generator and permits the use of RG59/U 75 ohm coaxial cable to interconnect the modulator to the R.F. amplifier without sacrificing the high frequency signal components. Since a fairly large cathode resistor is required to develop adequate signal, and since the plate current of V4 would generate excessive cathode to ground voltage and thus cut off V4, the grid of V4 was returned to a positive voltage which is adjustable by means of R15. This permits varying the bias on V4 which does 2 things; the grid operating point is varied, and the bias to the R.F. output amplifiers V4, 5 Fig. 4-2 is also varied. Since the R.F. amplifier output will increase with a decrease of its cathode voltage, it follows that sync peaks will have a peak negative value at the grid of V4, Fig. 4-1. The modulator tube V4 is a 6AQ5 connected as a triode and exhibits some signal compression at the negative peak of the signal. The MOD BIAS control R5 should be adjusted so that the signal does swing into this non-linear region. The amplitude compression will then be minimum.

d. REGULATED POWER SUPPLY. - Refer to schematic Fig. 4-4. This power supply is a conventional electronically regulated supply. The only novel feature is the use of V5 as a delay tube to prevent the output voltage from rising above 250 volts and permitting the heater of V6 to reach normal operating temperature. The operation of this circuit is quite simple. When V5 heater is cold the plate load of V6 pin 1 is 2.7 Meg. R8, also there is a voltage divider consisting of R7 and R6 totaling 540 K in series with R8 to ground. When V5 is cold or removed from the circuit this network causes a large negative voltage to be applied to the grids of V2, 3, 4, thus cutting off the plate current and thereby limiting the output voltage of the supply to a safe value. When V5 heats up the internal resistance between pins 7 and 1 becomes very low thus in effect connecting pin 1 to the 250 volt side of R8 thereby shunting R8 with R7 and making the plate

load of V6 at pin 1 actually 270 K which is the proper operating value. When this takes place R6 becomes a shunt bleeder of 270 K to the 250 volt output and plays no part in the operation of the supply.

e. OUTPUT CHOPPER RELAY. - This relay is shown on schematic Fig. 4-5 as K1. It is a special relay having special contact clearances and adjustments to prevent "bounce" of the contacts. It is operated by a 6.3 V.A.C. 60 cps source. Its purpose is to produce a zero signal reference line at the "MON" output when viewing the signal with a scope, by shorting the output of the rectifier to ground at a 60 cycle rate.

f. A.F.C. TUNING INDICATOR. - The tuning indicator is mounted on the front panel with the A.F.C. switch and sound oscillator tuning condensor. Its purpose is to indicate when the sound oscillator is on frequency. Proper sound carrier frequency is indicated by the alignment of the tops of the two shadows with each other and a maximum elevation of the bottoms of the two shadows. This check should be made with the A.F.C. switch in the "OFF" position. The A.F.C. switch should then be turned "ON."

SECTION 4

MAINTENANCE

1. GENERAL

Since the Type 2120-A is generally subjected to continuous operation, the vacuum tubes should be completely replaced every 3 months and positively at the end of 6 months service. It is recommended that a service record be maintained and specific check dates be set up so as to assure the best possible service from this instrument.

2. NO PICTURE OR SOUND CARRIER

Using a Voltohmyst check the various test points to determine which section of the R.F. generator is defective. Approximately the following readings should be obtained at the TP's indicated. The readings are for channels 7 - 13 units; for channels 2 - 6 units skip checks on omitted TP's on chassis.

TP1	-8V	TP8	-54V
TP2	-9V	TP9	-54V
TP3	-9V	TP10	-42V
TP4	-11V	TP11	-42V
TP5	-12V	TP12	- 9V
TP6	-8V	TP13	-10V
TP7	-20V	TP14	-29V
		TP15	-20V

Remove tube of stage involved and check for characteristics. If tube is O.K. remove bottom shield and check circuit voltages by means of Table 2.

3. NO VIDEO MODULATION

Using a DuMont Type 303 or Tecktronics 524 or 514 scope, check at J1 Fig. 4-1 to determine whether Video signal is at input of amplifier. If present in correct amplitude, check at J2 and note amplitude. If signal is absent, check at grid of V2, V3, and V4 to determine where the fault lies. If video signal of about 2 to 3

volts is present at J2 then check at Pin 7 V4 and V5 Fig. 4-3 to check for faulty cable connections. By this time the trouble should be found but occasionally one or both V4 and V5 may develop peculiar characteristics that makes it necessary to replace them. As a last resort change V4 and V5.

4. SOUND CARRIER OFF FREQUENCY

This is usually caused by accidentally misadjusting C91 or C92 Fig. 4-3. If C91 or C92 is adjusted beyond the control range of the AFC circuit then the AFC circuit will not "pull in" the sound oscillator. Assuming that there is no defect in the VAFCAO chassis Fig. 4-1 the oscillator can be set up as follows:

Turn the AFC switch S3 on VAFCAO chassis to OFF. Be sure both sound and picture carriers are "ON" and remove video input to J1. Couple a BC 221 Frequency Meter or other suitable frequency measuring equipment to the coil L9 by stray capacitance and set the sound carrier to the frequency listed for the sound carrier on Fig. 4-2 and 4-3. Condenser C92 (at the top of the chassis) should be set for mid-range and C91 (bottom of chassis) should be adjusted to obtain the desired frequency.

Now connect the BC221 to the "MON" terminals on the front panel and connect a V.T.V.M. on TP2. Be sure both sound and video carriers are "ON" and video and sound modulation is removed. Adjust sound osc. frequency be means of C92 (top of chassis) to obtain a 4.5 MC signal. The voltage at TP2 should be -3.0 ±.1 volts. If the voltage at TP 2 is other than -3.0 ±.1 volts, adjust secondary of discriminator transformer T3 (bottom slug) and C92 simultaneously to obtain a 4.5 MC signal and TP2 voltage of -3.0 ±.1 volts.

Now adjust C92 slightly so as to either increase or decrease the sound oscillator frequency by about 15 or 20 KC and operate the AFC switch to "ON", the frequency should snap back to the correct value. If it does not do so, then check the alignment of the AFC system. Then readjust C92 to center frequency.

5. AFC SYSTEM ALIGNMENT

Apply a 1 volt 455 KC signal to J-3 through a 0.01 mf blocking capacitor. Place a voltohmyst on TP1, tune 455 KC transformer T2 for maximum output with Audio Switch "OFF." Voltage reading will be approximately 20 to 25 V negative. Now place Voltohmyst on TP2 and tune primary winding to T3 which is the slug near the top of the can for maximum output. Then tune secondary or bottom slug for -3.0 V

output. During these adjustments the AFC switch if "OFF". After adjusting the discriminator transformer T3 note whether output voltage at TP2 increases in positive direction when increasing frequency of 455 KC signal generator. If voltage goes more negative, then the green leads on T3 to V6 should be reversed (pins 2 & 7). Proper alignment of the discriminator should produce a ±15 volt swing for a frequency change of ±15 KC. Remove the signal generator and 0.01 mf capacitor from J3 and connect cable to J3. Remove AFC crystal X2 on R.F. chassis and connect a 1 volt output 455 KC generator in its place making sure that the "HOT" side of the generator is connected to the ungrounded pin of the crystal socket X2. Connect the voltohmyst to TP1 (VAFCAO chassis) and tune L18 on R.F. chassis for maximum output, approximately -29 V. Move the Voltohmyst to TP14 and Tune L16 for maximum output, approximately -46 V.

6. POWER SUPPLY

When testing the power supply with the output disconnected from the VAFCAO chassis or R.F. chassis be sure to connect an electrolytic capacitor of at least 10 MF across the output pin 1 J1 Fig. 4-4 to ground. If this is not done the supply will go into a high frequency oscillation and the output voltage control R15 will appear to be inoperative. The hum level with normal load of 200 mils at 250 volts should be less than 5 millivolts.

TABLE 1

VAFCAO CHASSIS

Tube	Tube Pin Number								
	1	2	3	4	5	6	7	8	9
V1	0	230	0	6.3 AC	230	230	5	-	-
V2	0	0	0	6.3 AC	220	130	0.9	-	-
V3	0	0	0	6.3 AC	210	130	0.7	-	-
V4	*1	+20	0	6.3 AC	230	230	1	-	-
V5	TP1-9	0	0	6.3 AC	140	90	0	-	-
V6	TP2-3	-50	0	6.3 AC	-3	0	-60	-	-
V7	230	20	28	0	0	150	-0.7	1	0

Readings taken with no video input to J1
*Approximate readings with R15 set for maximum R. F. output. (may vary)

TABLE 2

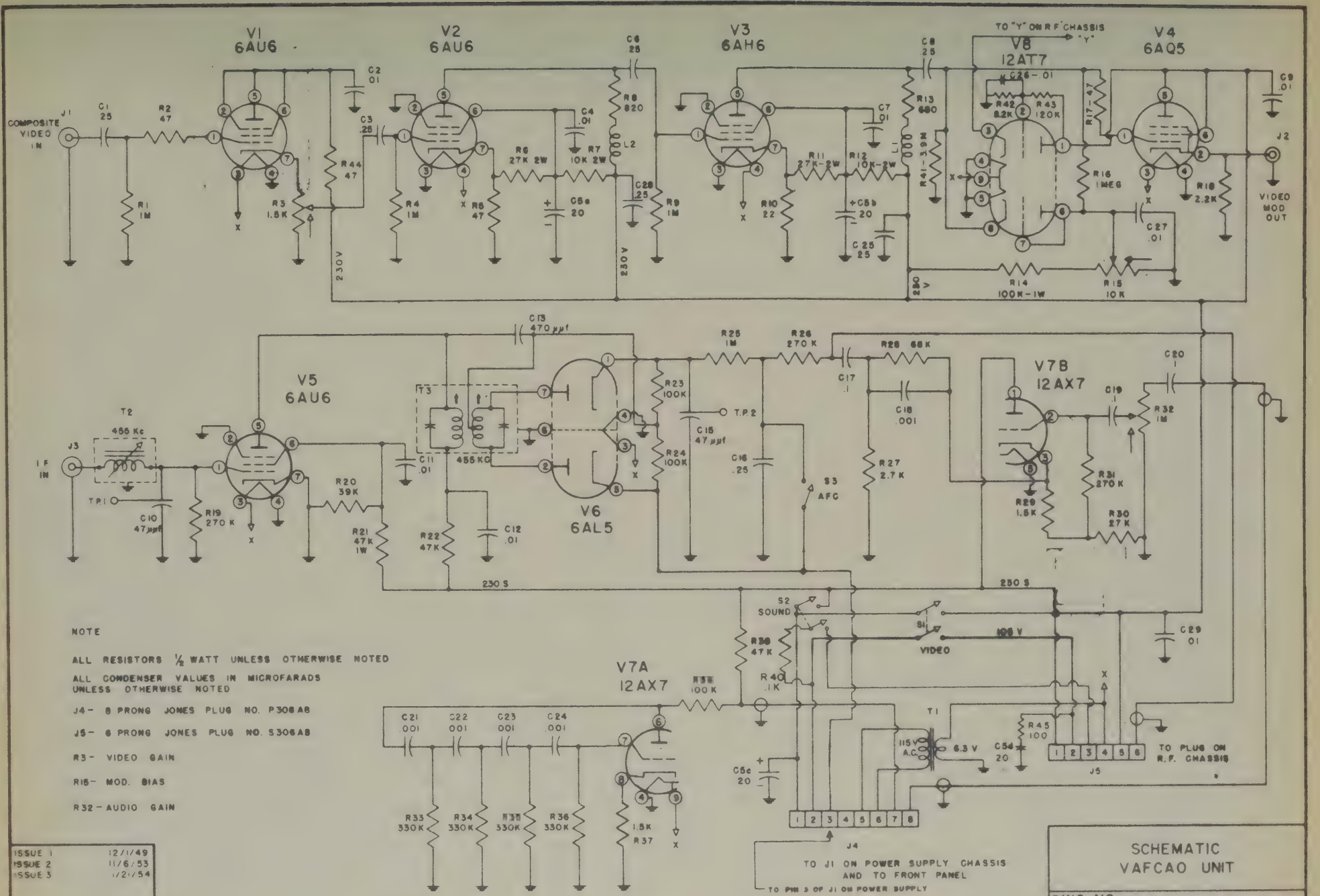
R. F. CHASSIS

Tube	Tube Pin Number								
	1	2	3	4	5	6	7	8	9
V1	200	0	2	0	0	190	TP1-6	2	6.3 AC
V2	210	210	6.3 AC	0	TP2-6	TP3-6	5	-	-
V3	230	230	6.3 AC	0	TP4-7	TP5-7	-5	-	-
V4	19	0	6.3 AC	0	230	100	+20	-	-
V5	19	0	6.3 AC	0	230	100	+20	-	-
V6	230	TP7-34	0	0	0	220	-80	3	6.3 AC
V7	220	220	6.3 AC	0	TP9-46	TP8-40	4	-	-
V8	220	220	6.3 AC	0	TP11-17	TP10-17	5	-	-
V9	TP12-4	0	6.3 AC	0	230	150	2.6	-	-
V10	TP13-5	0	6.3 AC	0	230	150	2.6	-	-
V11	-8	0	6.3AC	0	230	100	-3	-	-
V12	-40	0	6.3 AC	0	230	50	.9	-	-
V13	TP15-20	0	6.3 AC	0	230	100	TP14-9	-	-

TABLE 3

POWER SUPPLY

Tube	Tube Pin Number								
	1	2	3	4	5	6	7	8	9
V1	230	400	-	560 AC	220	560 AC	-	400	-
V2	-	230	380	-	220	220	230	-	-
V3	-	230	380	-	220	220	230	-	-
V4	-	230	380	-	220	220	230	-	-
V5	230	230	230	230	230	-	230	-	-
V6	230	130	130	230	230	130	90	90	230
V7	-	130	60	130	230	65	130	-	-
V8	230	90	30	90	230	30	90	-	-
V9	105	Grd	-	-	105	-	-	-	-



NOTE

ALL RESISTORS ½ WATT UNLESS OTHERWISE NOTED

ALL CONDENSER VALUES IN MICROFARADS UNLESS OTHERWISE NOTED

J4 – 8 PRONG JONES PLUG NO. P308AB

J5 – 6 PRONG JONES PLUG NO. S306AB

R3 – VIDEO GAIN

R15 – MOD. BIAS

R32 – AUDIO GAIN

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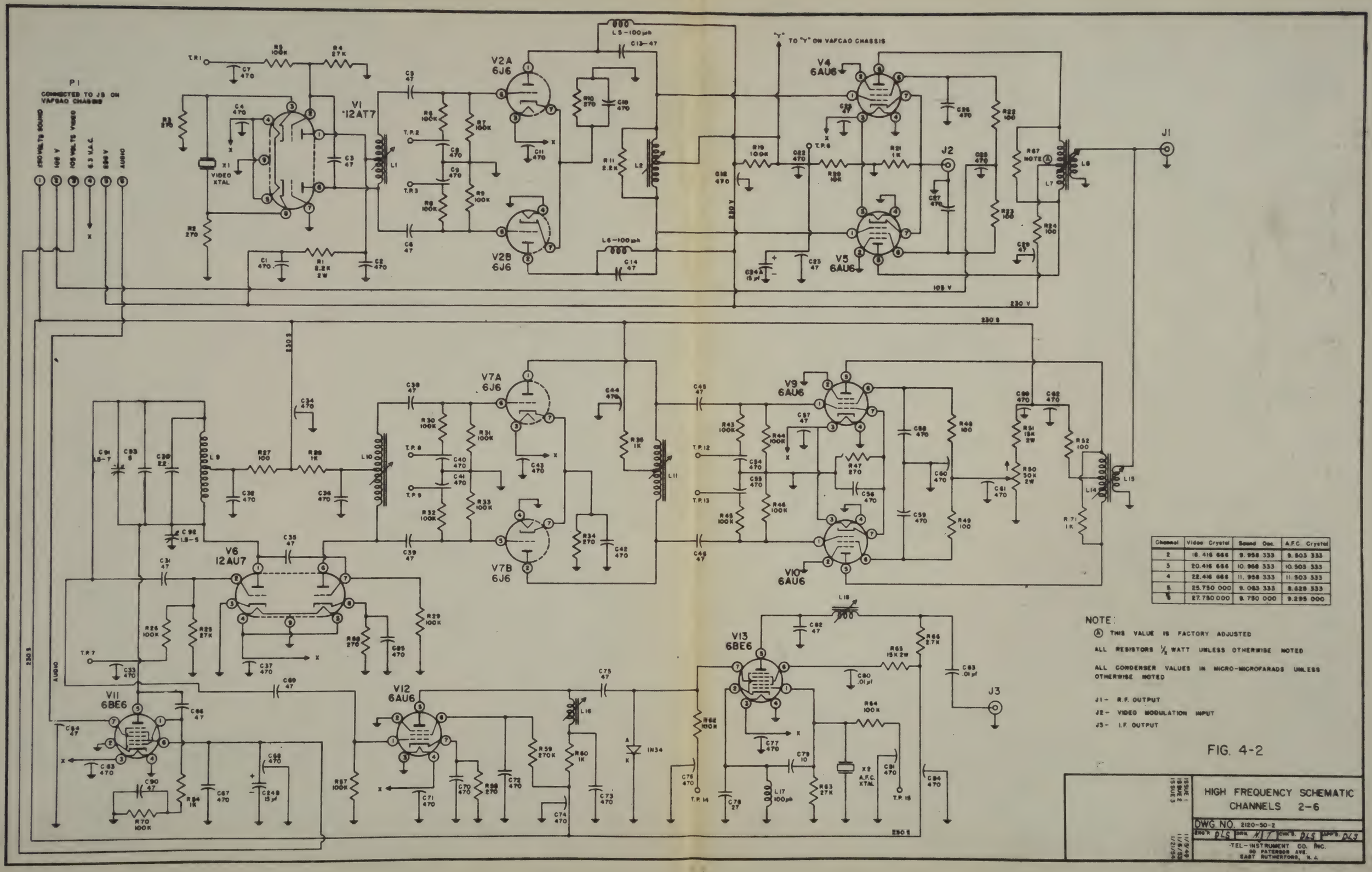
FIG. 4-1

SCHEMATIC
VAFCAO UNIT

DWG. NO. 2120-50-1

DWN. M.S. DATE 1/1 CHK'D RZ APP'D RZ

TEL-INSTRUMENT CO. INC.
50 PATERSON AVE
EAST RUTHERFORD, N.J.



Channel	Video Crystal	Sound Osc.	A.F.C. Crystal
2	18.416 666	9.958 333	9.503 333
3	20.416 666	10.958 333	10.503 333
4	22.416 666	11.958 333	11.503 333
5	25.750 000	9.083 333	8.628 333
6	27.750 000	9.750 000	9.295 000

NOTE:

(A) THIS VALUE IS FACTORY ADJUSTED

ALL RESISTORS ½ WATT UNLESS OTHERWISE NOTED

ALL CONDENSER VALUES IN MICRO-MICROFARADS UNLESS OTHERWISE NOTED

J1 - R.F. OUTPUT

J2 - VIDEO MODULATION INPUT

J3 - I.F. OUTPUT

FIG. 4-2

ISSUE 3	ISSUE 2	ISSUE 1	HIGH FREQUENCY SCHEMATIC CHANNELS 2-6
12/12/56	11/8/55	10/7/55	DWG. NO. 2120-50-2
			230 S DLS DRN. HF CHK'D. DLS APP'D. DLS
			TEL-INSTRUMENT CO. INC. 80 PATERSON AVE. EAST RUTHERFORD, N. J.

P1
CONNECTED TO J5
ON VAFCAO CHASSIS

230 VOLTS SOUND
105 V
105 VOLTS VIDEO
6.3 V.A.C.
230 V
AUDIO

"Y" TO "Y" ON VAFCAO CHASSIS

V1 12AT7
V2A 6J6
V2B 6J6
V3A 6J6
V3B 6J6
V4 6AU6
V5 6AU6
V6 12AU7
V7A 6J6
V7B 6J6
V8A 6J6
V8B 6J6
V9 6AU6
V10 6AU6
V11 6BE6
V12 6AU6
V13 6BE6

J1
J2
J3

X1 VIDEO XTAL
X2 A.F.C. XTAL

NOTE:

(A) THIS VALUE IS FACTORY ADJUSTED

ALL RESISTORS ¼ WATT UNLESS OTHERWISE NOTED

ALL CONDENSER VALUES IN MICRO-MICROFARADS UNLESS OTHERWISE NOTED

J1 – R.F. OUTPUT
J2 – VIDEO MODULATION INPUT
J3 – I.F. OUTPUT

Channel	Video Crystal	Sound Osc.	A.F.C. Crystal
7	19.472 222	9.986 111	9.931 111
8	20.138 888	10.319 444	9.864 444
9	20.805 555	10.652 777	10.197 777
10	21.472 222	10.986 111	10.531 111
11	22.138 888	11.319 444	10.864 444
12	22.805 555	11.652 777	11.197 777
13	23.472 222	11.986 111	11.531 111

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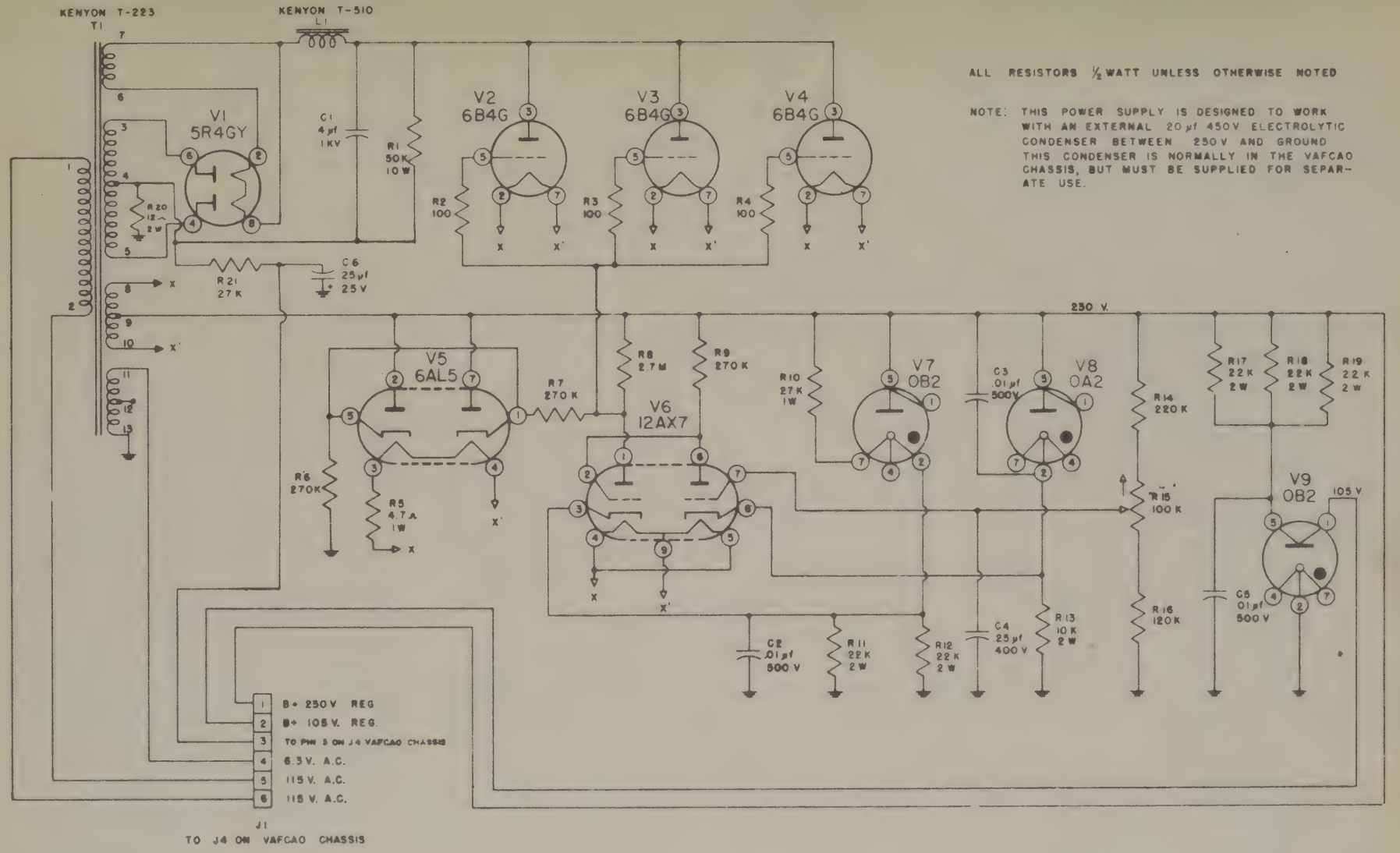
FIG. 4-3

HIGH FREQUENCY SCHEMATIC
CHANNELS 7-13

DWG NO 8120-50-3

ENG'R JAS DRN. MT CHK'D MS APP'D PCS

TEL-INSTRUMENT CO. INC.
80 PATERSON AVE.
EAST RUTHERFORD, N.J.



ALL RESISTORS ½ WATT UNLESS OTHERWISE NOTED

NOTE: THIS POWER SUPPLY IS DESIGNED TO WORK WITH AN EXTERNAL 20 µf 450 V ELECTROLYTIC CONDENSER BETWEEN 230 V AND GROUND THIS CONDENSER IS NORMALLY IN THE VAFCAO CHASSIS, BUT MUST BE SUPPLIED FOR SEPARATE USE.

FIG. 4-4

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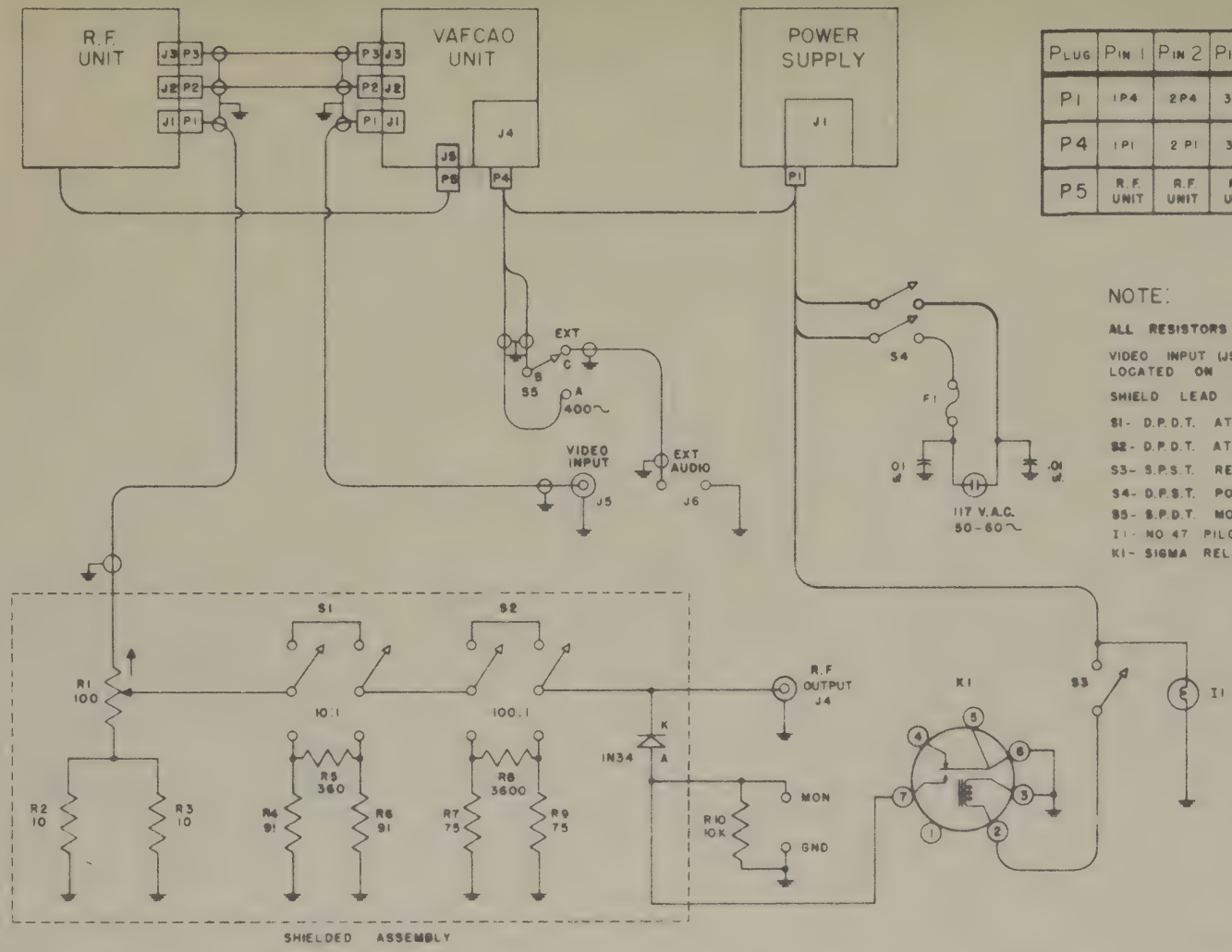
ISSUE 2
ISSUE 3 1/21/54

SCHEMATIC
POWER SUPPLY

DWG NO 2120-50-4

ENG'R BLE DRN MJ CHK'D BL APP'D BL

TEL-INSTRUMENT CO INC
80 PATERSON AVE
EAST RUTHERFORD, N. J.



PLUG	PIN 1	PIN 2	PIN 3	PIN 4	PIN 5	PIN 6	PIN 7	PIN 8
P1	1P4	2P4	3P4	S3 I1	S4 5P4	S4 6P4		
P4	1P1	2 P1	3 P1		5 P1	6 P1	S5A	S5B
P5	R.F. UNIT	R.F. UNIT	R.F. UNIT	R.F. UNIT	R.F. UNIT	R.F. UNIT		

NOTE:

ALL RESISTORS ½ WATT UNLESS OTHERWISE NOTED

VIDEO INPUT (J5) AND EXT. AUDIO (J6) JACKS ARE LOCATED ON REAR CHASSIS.

SHIELD LEAD CONNECTING 6P5 AND R.F. UNIT

S1- D.P.D.T. ATTENUATOR SWITCH
S2- D.P.D.T. ATTENUATOR SWITCH
S3- S.P.S.T. RELAY OPERATING SWITCH
S4- D.P.S.T. POWER SWITCH
S5- S.P.D.T. MODULATION SWITCH
I1- NO 47 PILOT LAMP
K1- SIGMA RELAY NO 77031

P1 - JONES PLUG NO. S306FHT
P4 - JONES PLUG NO S308FHT
P5 - JONES PLUG NO. P306FHT
F1 - 3 AMPERE FUSE

FIG. 4-5

ISSUE 1
11/5/49

INTERCONNECTING AND PANEL WIRING

DWG NO 2120-30 5

ENG'R DLS DRN [illegible] CHK'D DLS APP'D DLS

TEL-INSTRUMENT CO. INC
80 PATERSON AVE
EAST RUTHERFORD, N.J.

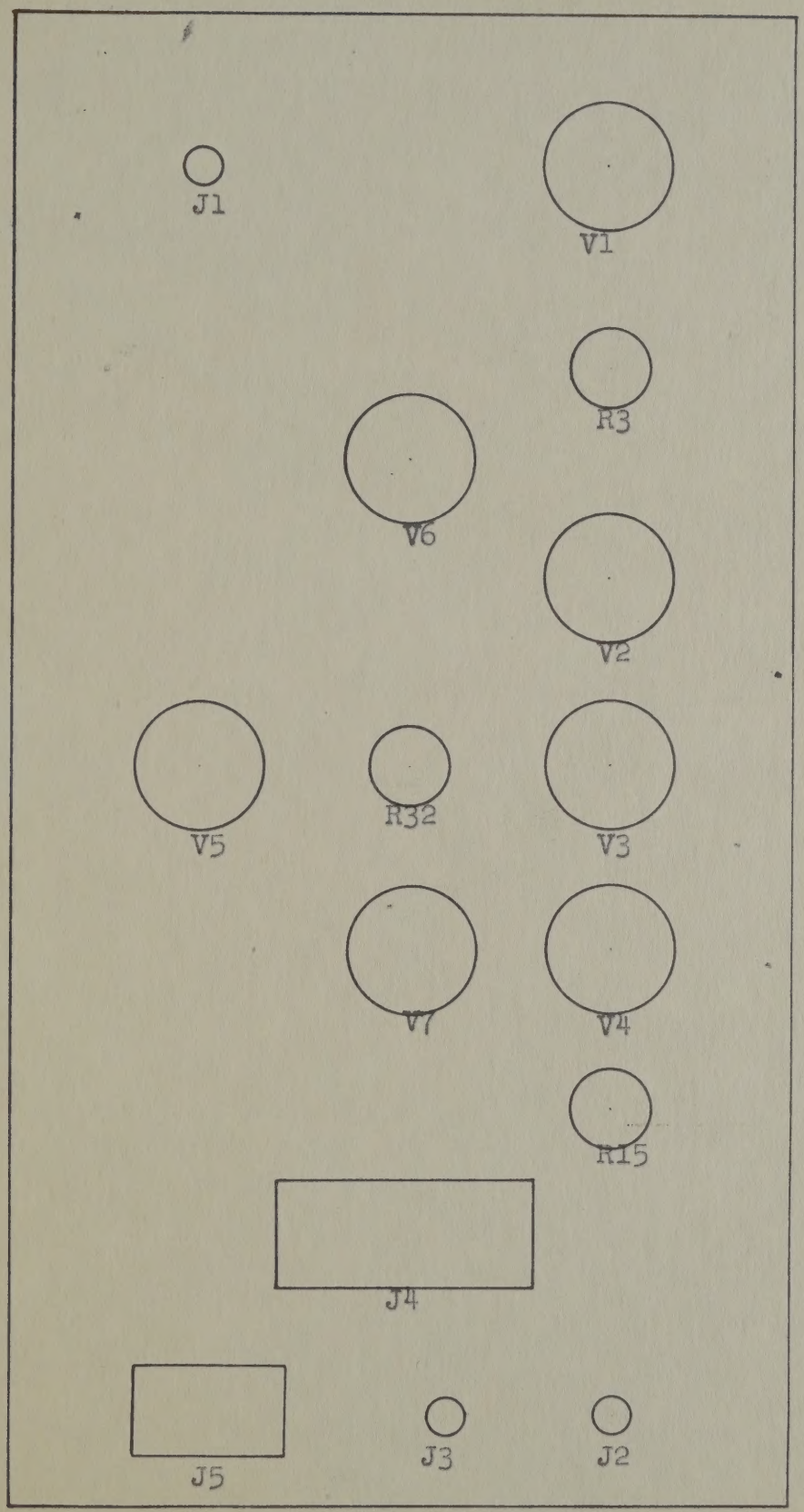


Fig. 4-6
VAFCAO CHASSIS
Bottom View